WE CLAIM:

-1-

A process for producing heteroepitaxial growth of a single crystal diamond film which comprises:

(a) forming an atomically flat stepped surface on a single crystal metal oxide substrate which has a crystal structure for depositing a film of epitaxial iridium to produce a (001) film on the surface;

(b) depositing the film of the epitaxial iridium metal on the oxide so that the (001) surface results;

(c) depositing by chemical vapor deposition (CVD) of diamond nuclei onto the iridium film on the substrate from a plasma produced from a mixture comprising methane and hydrogen gases with dc-biased ion bombardment onto the iridium film from the gases; and

(d) growing the diamond film on the diamond nuclei condensate and iridium film using CVD and the mixture of the methane and the hydrogen, without the dc-biased ion bombardment to form the single crystal diamond.

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The process of Claim 1 wherein in step a) the metal oxide substrate is selected from the group consisting of sapphire, strontium titanate, lanthanum aluminate and magnesium oxide.

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The process of Claim 1 wherein in step a) the atomically flat surface is provided by chemical, mechanical or thermal means.

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The process of Claim 1 wherein the d.c. bias is between -100 and -300 volts relative to a bias ring located within the plasma above the substrate.

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The process of any one of Claims 1, 2, 3 or 4 wherein the microwave frequency is between 900 MHz and 2.5 GHz, the methane to hydrogen ratio is between 0.002 and 0.04, and the temperature is between about 650 and 850°C.

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The process of Claim 1 wherein the substrate is electrically isolated from a support during the CVD.

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The process of any one of Claims 1, 2, 3 or 4 wherein the gases are essentially free of nitrogen.

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A process for producing a composite composition which comprises:

(a) forming atomically flat stepped surface on a single crystal metal oxide which has a crystal structure for depositing a film of epitaxial iridium to produce a (001) film on the surface;

(b) depositing the film of epitaxial iridium metal on the surface so that the (001) surface results; and

(c) depositing nuclei on the iridium film by chemical vapor deposition (CVD) from a plasma produced from a mixture comprising methane and hydrogen gases with dc-biased ion bombardment onto the iridium film from the gases to produce the composite composition.

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The process of Claim 8 wherein the substrate is sapphire.

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The process of Claim 8 wherein the dc bias is between -100 and -300 volts relative to a bias ring located in the plasma above the surface.

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The process of any one of Claims 8, 9 and 10 wherein the microwave frequency is between 900 MHz and 2.5 GHz, the methane to hydrogen rate is between 0.002 and 0.04 and the temperature is between 650 and 850°C.

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The process of Claim 1 wherein the substrate is electrically isolated during the CVD.

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The process of any one of Claims 8, 9, 10 or 12 wherein the gases are essentially free of nitrogen.

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A composite composition which comprises:

(a) an atomically flat stepped surface single crystal metal oxide substrate;

(b) a (001) film of epitaxial iridium deposited on the substrate; and

(c) an epitaxial single crystal diamond (100) film deposited on the iridium film.

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The structure of Claim 14 wherein the metal oxide is sapphire.

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A composite composition which comprises:

(a) an atomically flat step surface single crystal metal oxide substrate;

(b) a (001) film of epitaxial iridium deposited on the substrate; and

(c) single crystal diamond nuclei deposited on the iridium to produce the composite composition.

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The composite composition of Claim 16 wherein the metal oxide is sapphire.